# ORBIT Development: Status & Plans

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## ORBIT Mission:

**Design accelerator Rings with SC (bare Coulomb & wakes), stripping foil, and ECloud**

## History:

**Shell,** SuperCode by S.Haney, 1994-1999 (LLNL).

**Core, C++ classes:** J.Galambos, J. Holmes, D.Olsen (ORNL/SNS), A.Luccio, J.Beebee-Wang (BNL), 1999

## Applications:

**Primary computational tool for SNS design and operation.**

**Appropriate for injection painting, foil issues, SC, etc. in existing Fermilab accelerator chain.**

**Useful for Project X**

# ORBIT Development: Status & Plans

## Recent developments 1999- present:

**Shell:** SuperCode extension and migration ->Python.
**Core C++ classes:** extensively upgraded, revised, fixed.

- 2nd order matrix bug fix.
- RF dynamics bug fix.
- Multibunch mode.
- Painting.
- Foil implementations, dumpFoilHits bug fix.
- Longitudinal dynamics in injection painting.
- Ecloud, first trials.
- Extension of the SuperCode interface lexicon till the Python era.

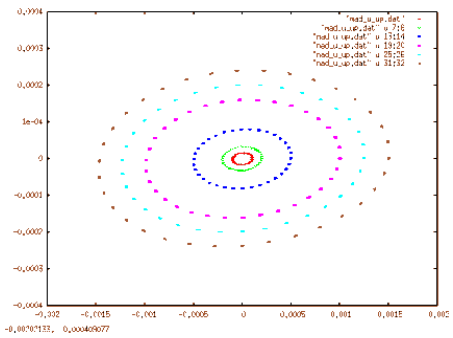
**Most of bug fixes were completed in close coordination with STRUCT (A.Drozhdin, et al.)**

# ORBIT 2nd order stuff

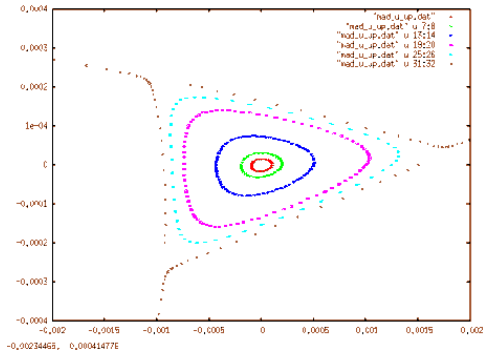
Exploring 3rd order resonance with tunes: $\nu_x = 6.676$, $\nu_y = 6.654$ in Fermilab Booster:

**MAD** tracking with sextupole components

No sextupole components(X,X') [m, rad]

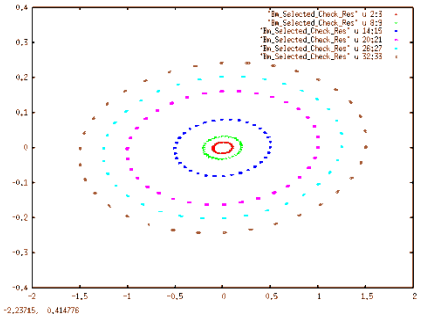


With sextupole components (X,X') [m,rad]

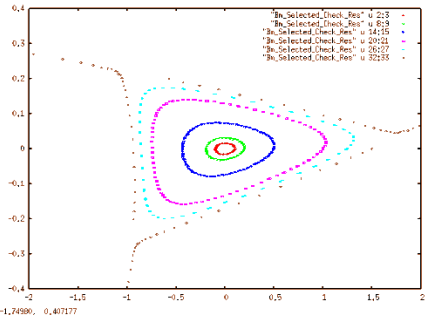


**ORBIT** tracking with sextupole components

Before correction (wrong) (X,X')[mm,mrad]



Corrected (identical to MAD) (X,X') [mm,mrad]



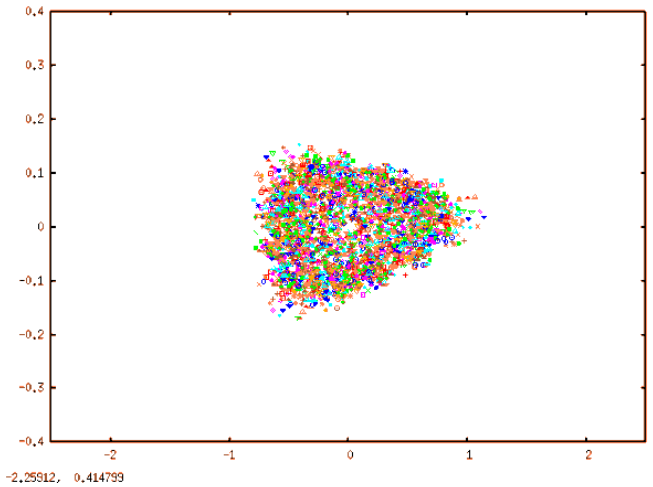
# ORBIT 2nd order stuff

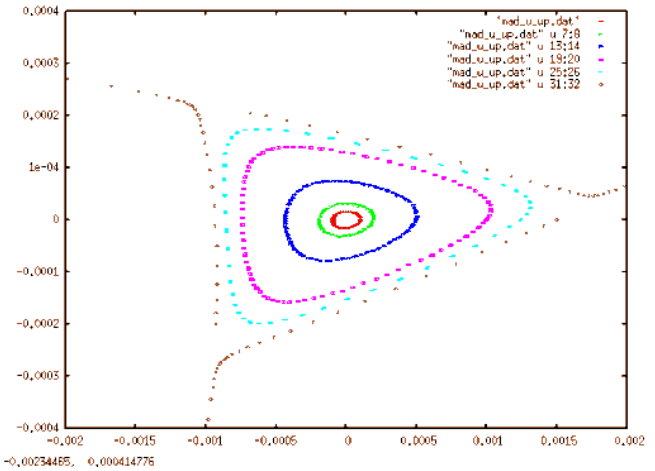
**ORBIT tracking multi-particle**

(within stable separatrix)

for some hundreds turns

Compare to 6 particles




A valid second order tracking is indispensable. Sextupoles. Very Large amplitudes (e.g., for painting) dynamics cann't be handled by Linear optics properly.

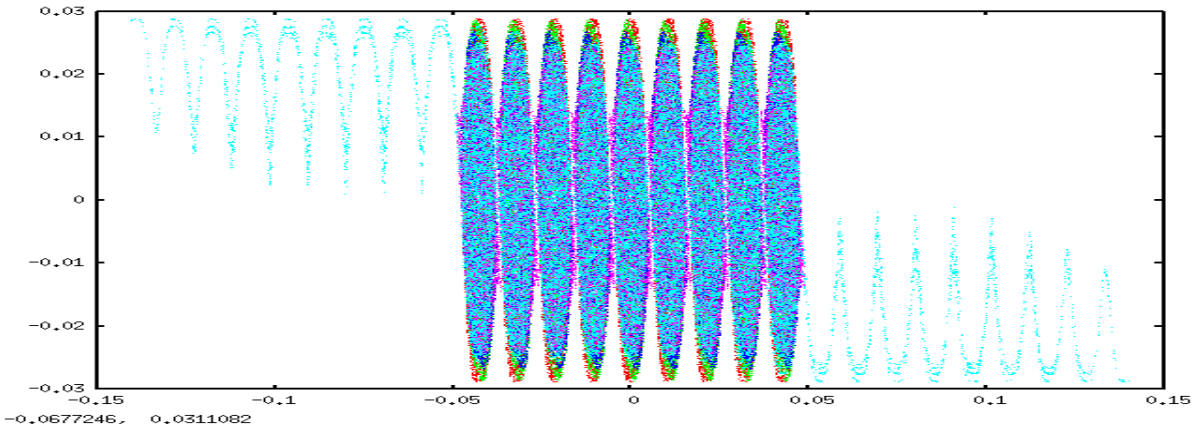
# ORBIT: Multibunches

**Test Run for Recycler**

**Dynamics through Δφ domain 0, 20, 30, 40, …, 1000 turns**

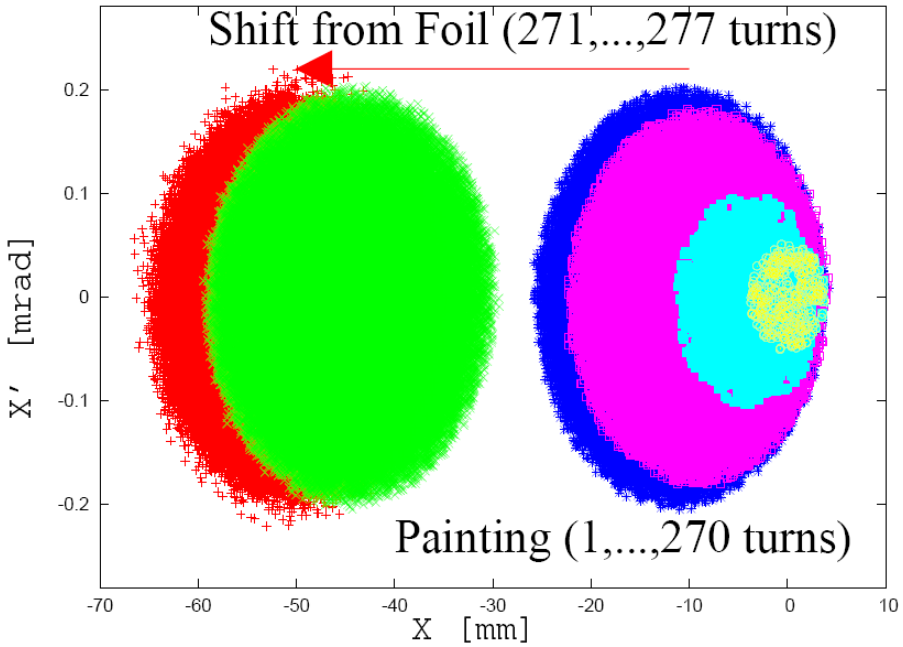
The distributions filled the separatrix deliberately. That's why those particles from the separatrix boundary migrates as expected.

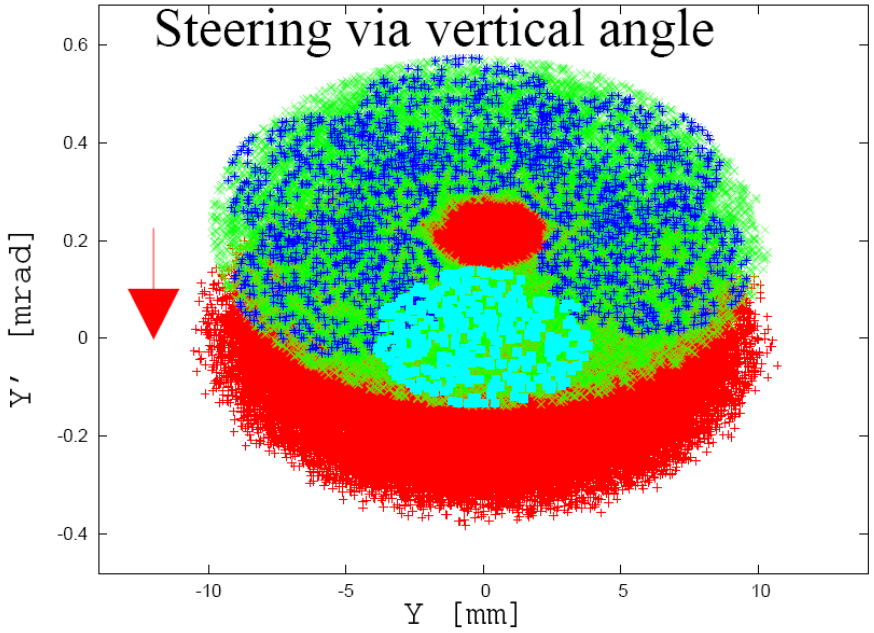
**(Δφ, ΔE)**




The trick is in substituting the real harmonic number (say 588 for MI) by harmonicNumber =1 and correspondingly scaling the RF harmonic

# ORBIT: Painting

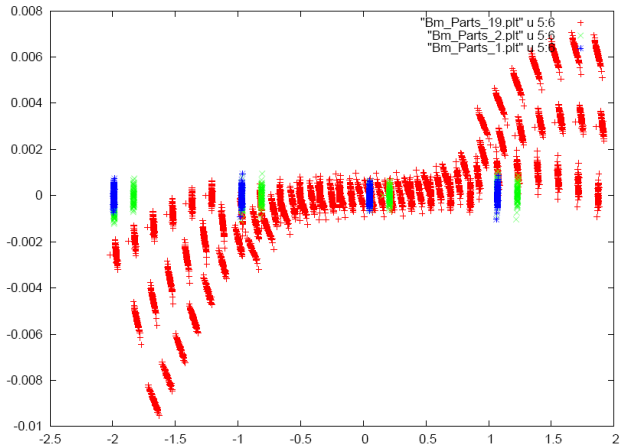


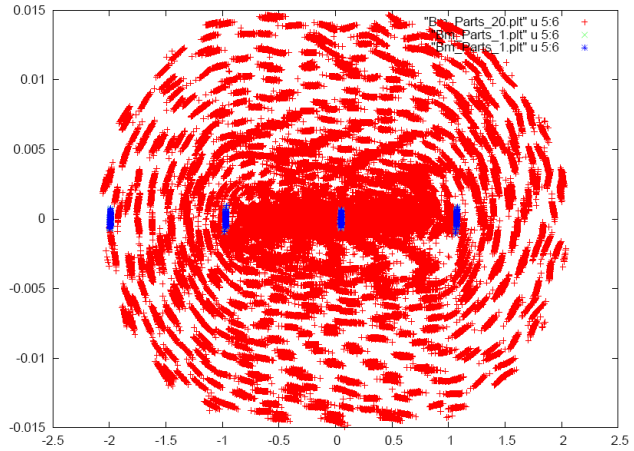

Painting in X-direction, Steering in Y-direction.

# ORBIT: RF bug fix & Longitudinal Painting

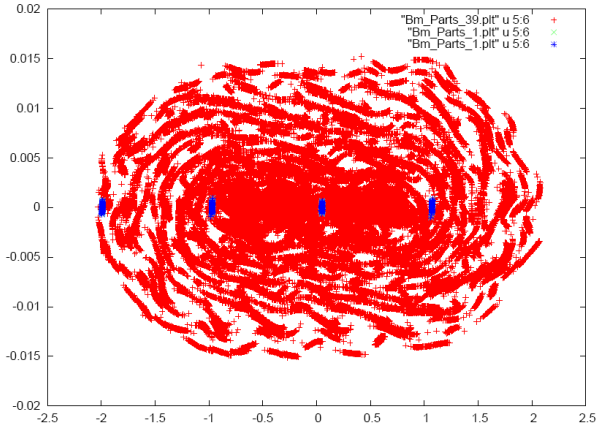
## Longitudinal Painting. Phase slippage. Chopping.




After 1, 2, 19 turns.



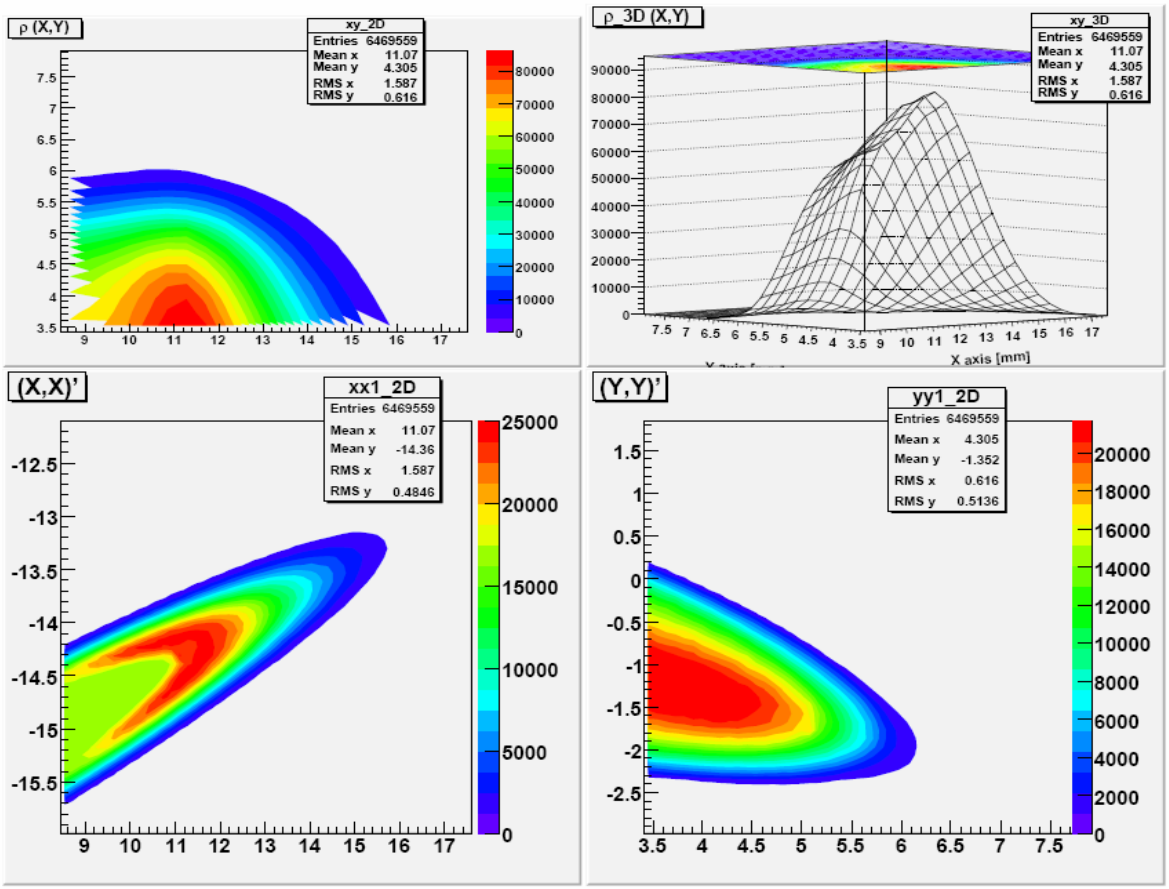

After 1 and 100 turns.




After 800 turns.

Note the vertical scales are different, the horizontal RF-gates are the same.

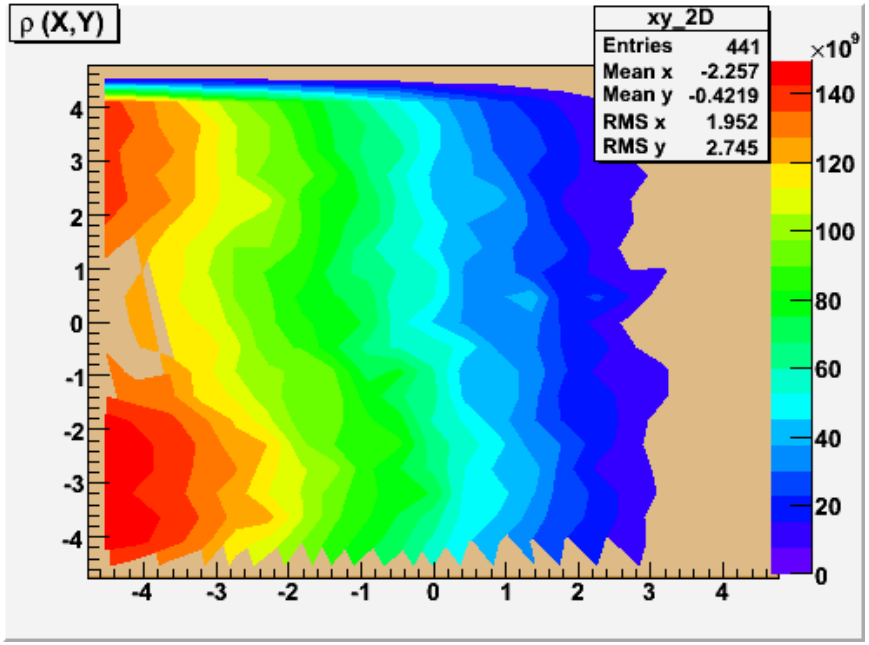
# ORBIT: Painting, Foil Issues

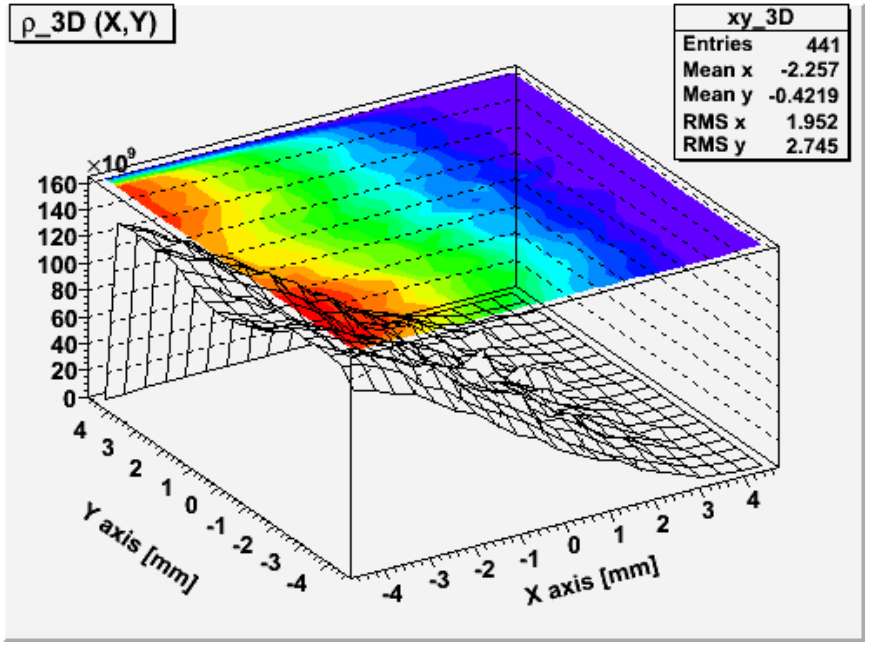



Foil heating may be an issue in ICD-2, especially when we inject during >2000 versus 270 in ICD-1

# ORBIT: Painting, Foil Issues

Two-hump hits distribution flattens the temperature distribution over the larger area

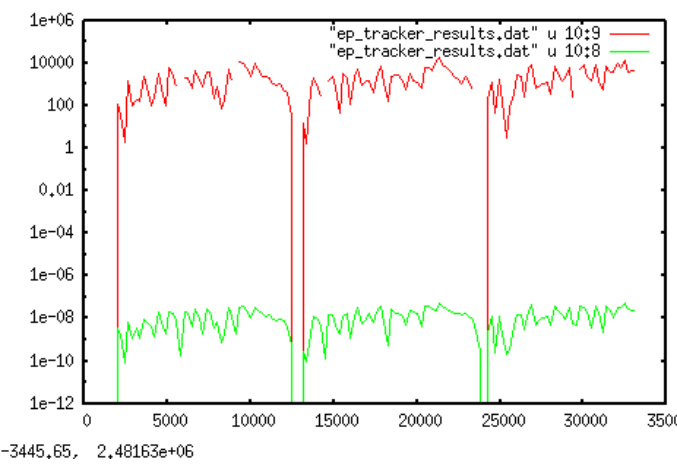


# ORBIT: ECloud status

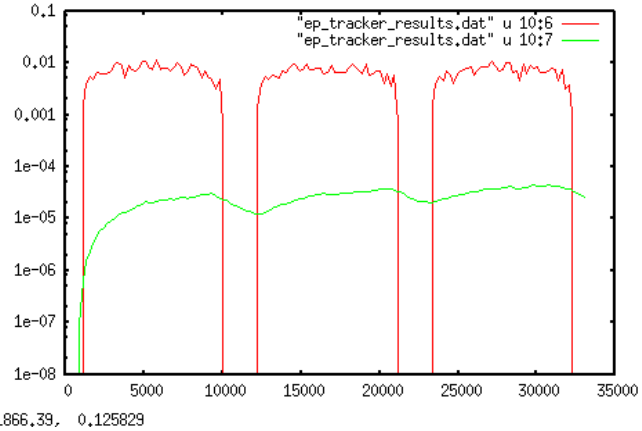
**Before corrections**

**Energy absorbed by surface (red, [MeV/sec/m]), Electron hitting surface (green [A/m])**



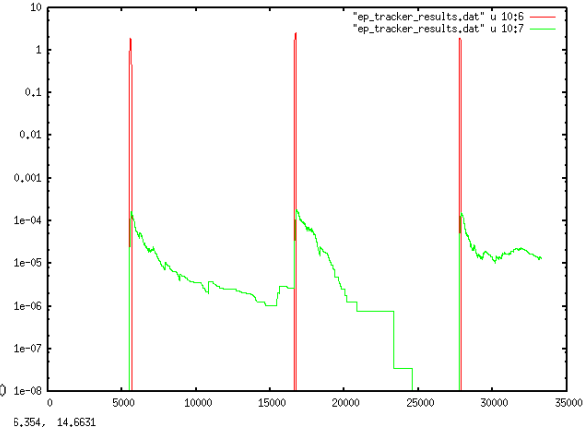

**Before corrections**

**Proton Beam line density (red, [nC/m]), Electron cloud line density(green, [nC/m])**




**After corrections**

**Proton Beam line density (red, [nC/m]), Electron cloud line density(green, [nC/m])**




All plots horizontal dimension in [ns], NOT turns!

For MI a revolution time 11123.1 [ns], a bunch length 18.9 [ns]

Principal problem was the Ecloud was 1 bunch mode dedicated.
SNS and PSR are right machines to model. MI has >500 bunches though.

# ORBIT: Foil hits and SuperCode extensions

## Recent fixes

- **A standard routine dumpFoilHit() was re-written. Before it was mixing a particle hit count with an actual density.**
- **A new routine importing lattice/Twiss parameter files. An arbitrary file with strings may be imported directly from SuperCode script.**

# ORBIT: Summary

## Further developments:

Foil and stripping
SuperCode extensions
Ecloud (for Bob Zwaska), Head-Tail modes (for Alexei)

## ORBIT users

Meigin Xiao, Dave Johnson
Vladimir Nagaslaev
Steve Werkema
Leonid Vorobiev

## Coordination & Validation with

SNS (J.Holmes) and STRUCT (A.Drozhdin)